IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of:
HILDEBRANDT, James
Serial No.: 10/560,743
Filed: December 15, 2005
HEADPHONES FOR 3D Sound

Docket No.: 2832149.001
Confirmation No. : 1692
Group Art Unit No: 2614
Examiner: Paul, Disler

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

2009-09-16

RULE 132 DECLARATION OF SEAN MURPHY

I, Sean Murphy, BASc., P.Eng., declare and state as follows:

1. I, Sean Murphy, BASc., P.Eng., of 50099 Township Road 282, Cochrane, Alberta, am a Principal Engineer at General Dynamics Canada, a major defense-electronics firm.

2. THAT I have over twenty years of career experience and training in audio technologies, including professional recording and broadcast, audio system and audio circuit design, and that I am currently working on the design of the next generation of audio intercom and networking equipment for General Dynamics Canada.

3. That I have evaluated technologies that may be used to enhance General Dynamics products and systems, including technology to spatially separate audio reception for enhanced hearing cognition and mission effectiveness.

4. THAT I have read the disclosure of U.S. Patent Application Serial No. 10/560,743 (hereinafter the "'743 Application") and the Office Action issued by Examiner Paul

on June 8, 2009 (hereinafter "the Office Action") in connection with the '743 Application, and I make this Declaration as evidence that one skilled in the art would not consider the invention of claims 2 to 21 of the '743 Application to be obvious based on U.S. Patent No. 6,038,330 to Meucci Jr. (hereinafter "Meucci").

5. THAT based on my understanding of the technology described in the '743 Application and considering my own experience and training in the field, I believe I am a person of skill in the art.

6. THAT I have read Meucci, which I understand to describe a virtual sound headset apparatus for simulating spatial sound. The headset includes left and right headphones interconnected by a headband; each headphone including a hollow casing forming an interior chamber for receiving one of the listener's ears and a plurality of sound focusing assemblies mounted on the casing.

7. THAT the sound focusing assemblies described by Meucci are spaced apart from one another and in acoustic communication with the corresponding interior chamber; and each sound focusing assembly includes (i) an electroacoustic transducer for reproducing sound in response to an electric input signal, and (ii) a mechanical-acoustic means for mounting the electroacoustic transducer on the casing.

8. THAT the mechanical-acoustic means described by Meucci focuses the sound emanating from each transducer to simulate a directional orientation of the sound toward the pinna of the corresponding ear.

9. THAT the mechanical-acoustic means described by Meucci is formed by an outer tube having an inner diameter sized to allow the transducer to be disposed within the outer tube, an inner tube coaxially disposed with and radially inward of the outer tube, and a sound-absorbing material disposed within the outer tube and surrounding a longitudinally extending portion of the inner tube.

10. THAT the inner tube described by Meucci has an open end that receives sound from the transducer which is substantially parallel to the longitudinal centerline axis of the tube, and allows this directionalized sound to travel to the interior chamber of the respective headphone and to the pinna of the listener's respective ear. Sound emanating from the transducer in directions not substantially parallel to the centerline axis of the tube propagates directly or indirectly to the sound-absorbing material between the inner and outer tubes and is substantially absorbed.

11. THAT the tubes of Meucci's mechanical-acoustic means are different in structure and functionality from the tubes incorporated in the headset design claimed in the '743 Application. Specifically, the tubes described by Meucci are very short and extend from the transducer to the interior chamber of only one of the respective headphones, thereby facilitating sound focusing; whereas the tubes of the headset apparatus claimed in the '743 Application extend from one side of the listener's head to the other forming terminal outlets at each of the listener's ears, thereby allowing for speakers to be positioned between the listener's two ears such that important spatial cues can be physically simulated to produce a surround sound effect.

12. THAT Interaural Time Difference (ITD) and Interaural Level Difference (ILD) are two spatial cues enabled by the headset apparatus of the '743 Application that cannot be obtained by simply adopting the tube features of Meucci.

13. THAT attached as Exhibit 'A' is a technical paper entitled "Azimuth Cues" (citation: http://interface.cipic.ucdavis.edu/CIL_tutorial/3D_psych/azimuth.htm; hereinafter "Exhibit 'A'"), in which ITD and ILD are discussed for technical background.

14. THAT Meucci provides no guidance or suggestion to provide physical simulation of spatial cues such as ITD and ILD using a sound path or tubes stretching from one ear to the other, and if full surround sound was desired by one reading Meucci's disclosure they would expect that these effects would need to be simulated through

modulation of the timing, volume and frequencies of the sound emanating from each transducer using an electronic controller and appropriate software.

15. THAT headphones are known which try to simulate 3D sound using software (HRTF methods) or multiple speakers in each earpiece but neither method correctly reproduces directional cues to everyone, in part because each person's head and ears are unique. The use of multiple speakers and/or software to simulate 3D sound has therefore not resulted in true surround sound, just left/right stereo, and if there is any front-to-back effect it typically does not sound natural.

16. THAT I have reviewed and tested a headset of the design claimed in the '743 Application, which is currently produced by Psyko Audio Labs Inc., of Suite 405, 3553 - 31 Street NW, Calgary, AB, Canada T2L 2K7, and which can be viewed on the company's website at http://www.psykoaudio.com.

17. THAT the Psyko Audio Labs Inc. headset incorporates at least first and second speakers, each speaker having a speaker chamber extending posteriorly, and being connected anteriorly to a speaker tube adjacent a respective first end thereof, wherein the first end of the first tube to which the first speaker is connected is continuous with the first end of the second tube to which the second speaker is connected such that sound paths of the first and second tubes meet intermediate the first and second speakers. The first and second tubes each terminate in an outlet at their respective second ends, the outlet of the first tube being positioned at a user's first ear and the outlet of the second tube being positioned at a user's second ear.

18. THAT because the first and second speakers are separately positioned along the sound path of the first and second tubes, spatial cues such as ITD and ILD can be modulated by adjusting the spacing between the speakers and/or by inserting sound absorbing material within the first and second tubes between the first and second speakers.

19. THAT the Psyko Audio Labs Inc. headset also incorporates third and fourth speakers and third and fourth tubes arranged in a similar manner to the first and second speakers and tubes. The combined four speakers are arranged as front right, front left, rear right, and rear left speakers based on where the tube outlets are positioned near the user's ears. A fifth center speaker is also provided on the headset to give full 5.1 surround sound.

20. THAT during testing I found the Psyko Audio Labs Inc. headset to have a fuller, more realistic and more natural surround sound production as compared to my experiences with known headphones incorporating software or multiple speakers in each earpiece to simulate the 3D sound.

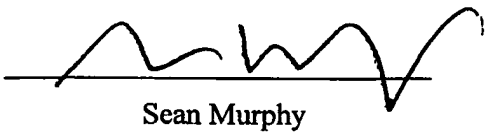
21. THAT by generating sound away from the ear and sending it to both ears along a sound path as defined in the '743 Application, the Psyko Audio headphones are able to utilize spatial cues such as ITD and ILD in a unique way to more naturally simulate a surround sound effect and improve over the known 3D headphones which only use software or multiple speakers in each earpiece.

22. THAT the separate positioning of the first and second speakers along the sound path of the first and second tubes as defined in the claims of the '743 Application, whereby the joined first and second tubes extend from one side of the listener's head to the other and form outlets at each of the listener's ears gives rise, at least in part, to the improvement in sound quality observed over the known 3D headphones such as that described in Meucci.

23. THAT I do not believe the invention claimed in the '743 Application is an obvious variation of the designer's choice producing no unexpected result, as asserted by Examiner Paul in the Office Action. Rather, as one of skill in the art I believe the headset claimed in the '743 Application is an inventive improvement over known 3D headphones.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patents issuing thereon.

6 Nov 2009
date

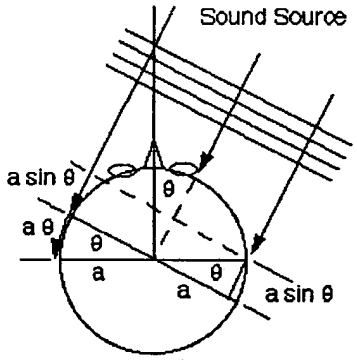


Sean Murphy

Exhibit 'A'

Azimuth Cues

One of the pioneers in spatial hearing research was John Strutt, who is better known as **Lord Rayleigh**. About 100 years ago, he developed his so-called **Duplex Theory**. According to this theory, there are two primary cues for azimuth -- Interaural Time Difference **(ITD)** and Interaural Level Difference **(ILD)**.



Lord Rayleigh had a simple explanation for the ITD. Sound travels at a speed c of about 343 m/s. Consider a sound wave from a distant source that strikes a spherical head of radius a from a direction specified by the azimuth angle θ. Clearly, the sound arrives at the right ear before the left, since it has to travel the extra distance $a\theta + a\sin\theta$ to reach the left ear. Dividing that by the speed of sound, we obtain the following simple (and surprisingly accurate) formula for the interaural time difference:

$$ITD = \frac{a}{c}(\theta + \sin\theta) \quad , -90^\circ \le \theta \le +90^\circ$$

Thus, the ITD is zero when the source is directly ahead, and is a maximum of $(a/c)(\pi/2+1)$ when the source is off to one side. This represents a difference of arrival time of about 0.7 ms for a typical size human head, and is easily perceived.

Lord Rayleigh also observed that the incident sound waves are diffracted by the head. He actually solved the wave equation to show how a plane wave is diffracted by a rigid sphere. His solution showed that in addition to the time difference there was also a significant difference between the signal levels at the two ears -- the ILD.

As you might expect, the ILD is highly frequency dependent. At low frequencies, where the wavelength of the sound is long relative to the head diameter, there is hardly any difference in sound pressure at the two ears. However, at high frequencies, where the wavelength is short, there may well be a 20-dB or greater difference. This is called the **head-shadow effect**, where the far ear is in the sound shadow of the head.

The Duplex Theory asserts that the ILD and the ITD are complementary. At low frequencies (below about 1.5 kHz), there is little ILD information, but the ITD shifts the waveform a fraction of a cycle, which is easily detected. At high frequencies (above about 1.5 kHz), there is ambiguity in the ITD, since there are several cycles of shift, but the ILD resolves this directional ambiguity. Rayleigh's Duplex Theory says that the ILD and ITD taken together provide localization information throughout the audible frequency range.

Reproduced from: http://interface.cipic.ucdavis.edu/CIL_tutorial/3D_psych/azimuth.htm